1. General information

The QMBox series devices are designed for automation of measurement and control units, used for vast spectrum of tasks, including laboratory research and industry automation. QMBox series includes sensor interrogation devices, various A/D and D/A converters and discrete I/O devices.

QMBox devices may contain measuring and control channels of different types: AD Converter+ DA Converter, or AD Converter + relay switching, or AD Converter + DA Converter + digital input, etc.

QMBox devices consist of a set of functional modules (ADC, DAC, Discrete I/O, etc.) installed in a single case. These modules can be combined in one device in any configuration comprising one to eight modules. This scalable modular architecture allows to:

- combine all necessary functions in one device;
- automate small installations requiring only a few measuring channels, as well as to create large measuring systems for hundreds of channels.

2. Architecture

Depending on the number of modules, the device can be designed as a 1 -, 2 -, 3 - and 8-modular unit:

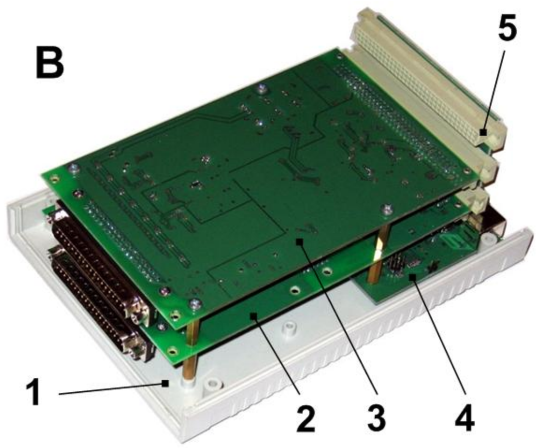
1 module case
140x190x40 mm

2 modules case
140x190x60 mm

3 modules case
140x190x80 mm

4 to 8 modules crate
260x260x160 mm

The two-module device (ADC + DAC) is used to demonstrate QMBox internal construction:



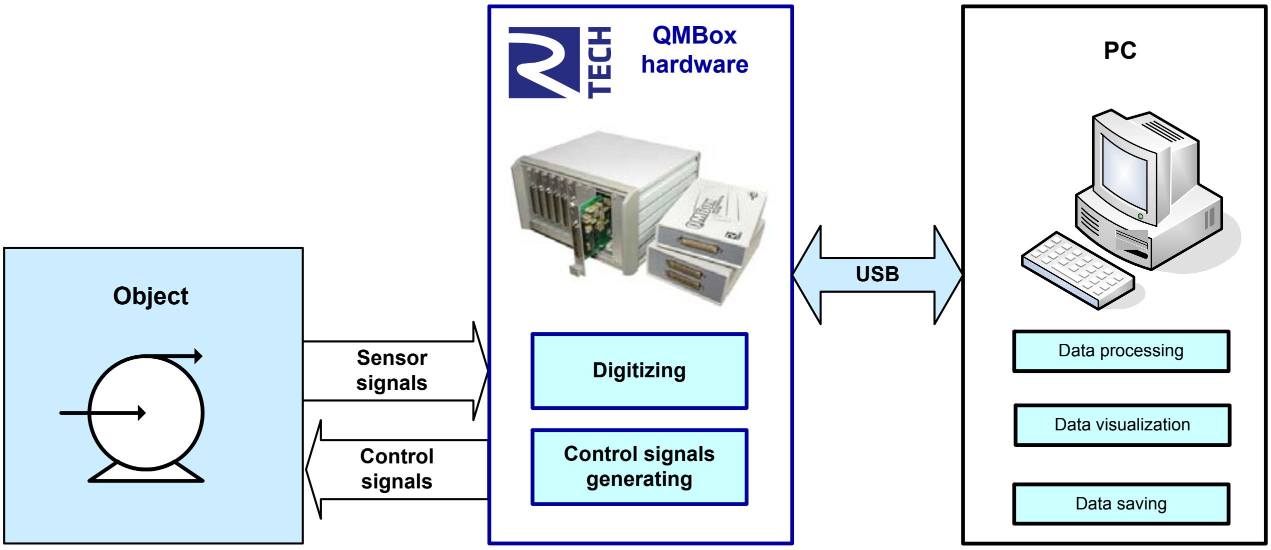
A – the assembled device; B – the same device with the cover removed;

1 – Bottom shell
2 – ADC module
3 – DAC module
4 – Interface board that controls operation of the modules and ensures connection of the device to the computer via USB
5 – Interconnect board that ensures electric connection of the modules to the interface board.

Inside the case the modules are plugged into the slots of the interconnect board. This board joins the modules into a single device and ensures electric connection of the modules to the interface USB board. The interface board controls operation of the modules and ensures connection of the device to the PC via USB.

3. Principle of operation

The QMBox series devices operate under PC control (OS Windows) via USB connection. The software supplied with QMBox devices performs stream input / output of data between the device and the PC memory, data processing and further visualization on the display as well as saving to the PC hard disk:



QMBox devices consist of a set of functional modules (ADC, DAC, Discrete I/O, etc.) installed in a single case. Depending on data transfer direction, all the QMBox modules can be subdivided into input modules (ADC and discrete input modules) and output modules (DAC modules).

Before starting work the configuration is performed by means of the software – the operation parameters of the modules of the device are set: sampling rate, the number of channels in use, etc.

After this the device is started, i.e. the data transfer session is launched.

During the data transfer session the input modules of the device (ADC modules, for example) digitize input signals at a pre-set rate and send the data through the interface board to the computer via USB. In the PC the data is put to a circular buffer in RAM. During the buffer filling, the data is taken from it by the application software for further processing, visualization and saving to the hard disk. Since the software takes data from the buffer at a rate higher than the rate of its receipt from the device, the data transfer session can last for however long, and data from the device is received by the computer without gaps. Thus, the device can be used as a full-fledged data recorder without record time limits.

Output modules (DAC modules) can operate in “stream” mode, too. This mode allows to generate non-periodic signals of arbitrary form and duration and to “play” files of arbitrary length through the DAC. In this mode the data in the internal buffer of the DAC module updates permanently from the PC RAM. The data transfer session can last for however long, and data from the PC RAM passes through the DAC without gaps.

4. Synchronization modes

All the modules installed in the device are clocked by the same generator on the interface board. That is why in the course of work the modules of the device are precisely synchronised with each other.

However, sometimes it is necessary not only to synchronize the modules with each other, but to precisely time the entire device to be started by a certain external event.

By default the device starts working (i.e. starts the data transfer session) since after issuing the command “Start” from a PC. This command can be executed within a few milliseconds. The exact execution time of this command under OS Windows (that is not a real-time OS) is impossible to be learnt in advance. For the cases when it is necessary to bind the start of the data transfer session to any external event with high precision one can use the external start synchronization mode. In this mode it is necessary to give a negative digital pulse (logical “1” - “0” - “1”) to the "SYN" contact of the device after the issuing the “Start” command. The data transfer session begins right after negative pulse edge (logical “1” to “0”) arrives. The duration of the SYN pulse (i.e. of the logic “0”) must be at least 50 ns. The “SYN” line has an internal pull-up resistor, so one can just short the “SYN” line to “ground” to generate the required pulse.

Switching between start synchronization modes of data acquisition is software-selectable.

5. Functional modules used in the QMBox series devices

QMBox devices consist of a set of functional modules (ADC, DAC, Discrete I/O, etc.) installed in a single case. These modules can be combined in one device in any configuration comprising one to eight modules.

5.1. QMS10 ADC Module

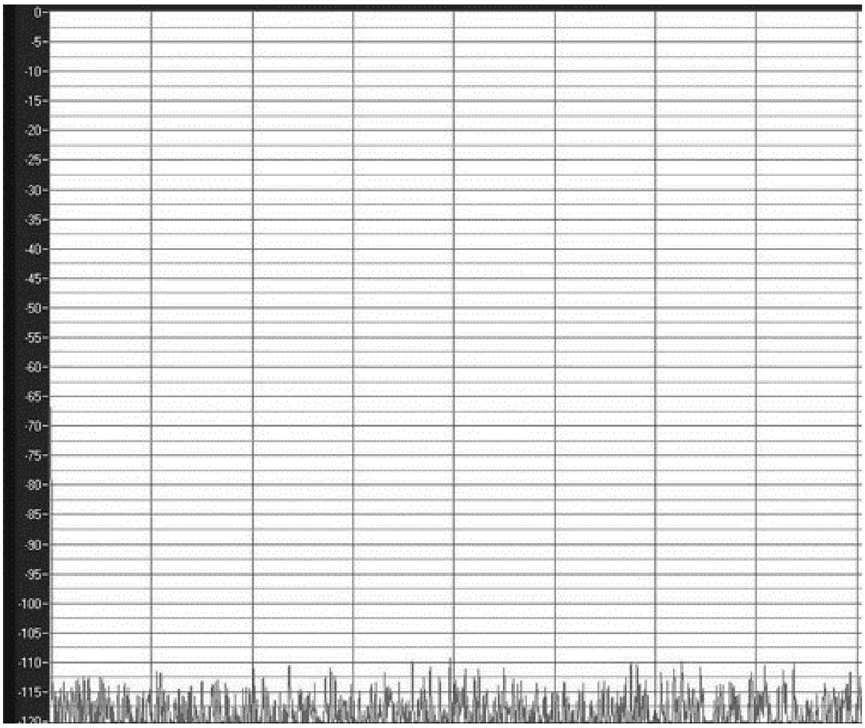
QMS10 is a multichannel ADC module with 16 differential / 32 single-ended analog inputs.

- Max. sampling rate (one channel): 0.4 MS/s
- Four input signal ranges: ±10 V, ±2.5 V, ±0.625 V, ±0.156 V (programmable per channel)

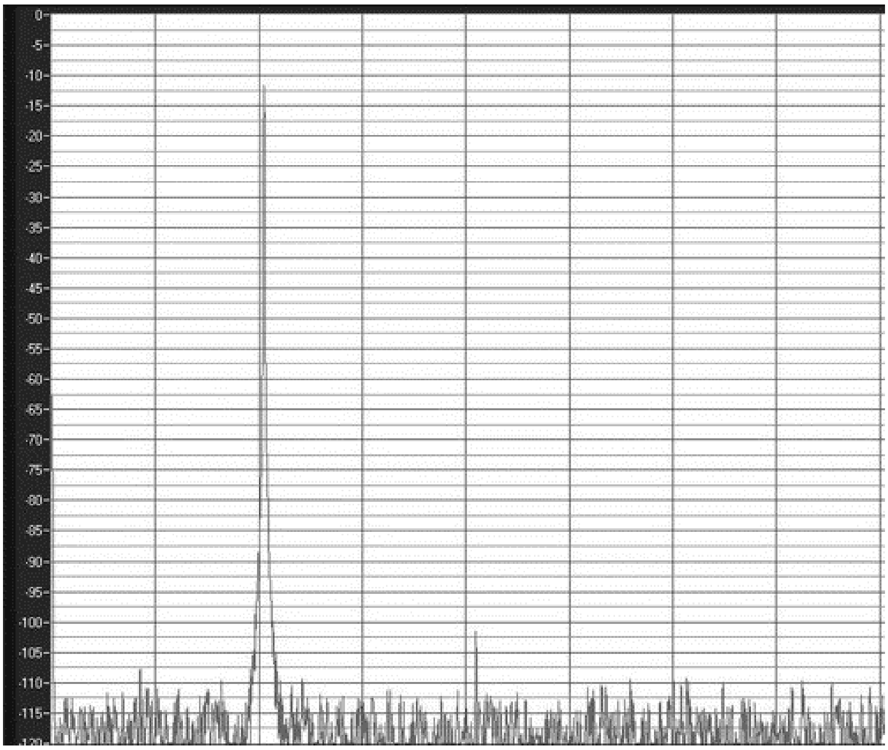
5.1.1. Specifications

Number of input channels	16 differential / 32 single-ended
Input signal range (programmable per channel)	± 10 V; ± 2.5 V, ± 0.625 V, ± 0.156 V
Max. aggregate throughput (all channels)	0.4 MS/s
Max. sampling rate (one channel)	0.4 MS/s
ADC resolution	14 bits
Sensitivity - at input range ± 2.5 V	0.7 mV
Reference limiting error	0.05 %
Typical common-mode rejection ratio (input signal 5 V, 10 kHz)	-75 dB
Typical crosstalk (for input signal 10 kHz with channel switching frequency 100 kHz at input ranges ± 10 V; ± 2.5 V, ±0.625 V)	-83 dB
Input overvoltage protection: - Permanent overvoltage (10 sec) - Impulse (1 ms)	±15 V ±50 V

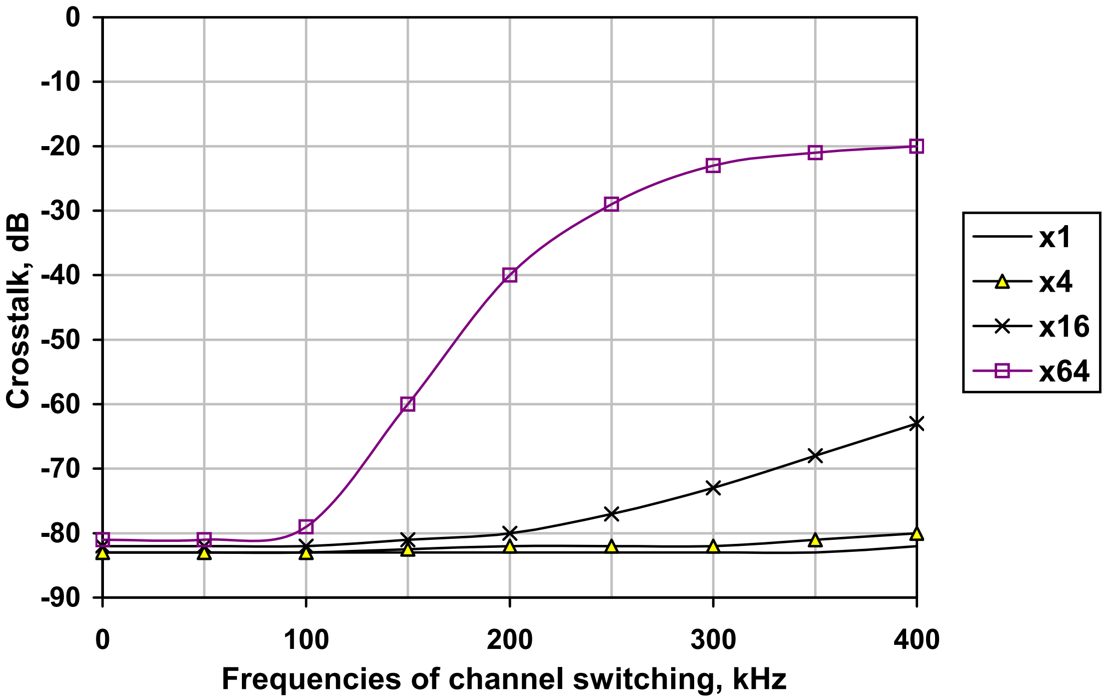
Figures below show typical characteristics of a QMS10 module: Harmonic distortion; noise in the ½ f_{ADC} band; the graph of Crosstalk dependency towards channel switching frequency.



Noise in the ½ f_{ADC} band (f_{ADC} = 400 kHz)



Harmonic distortion. Input signal - sine-wave 10 kHz, 3V. f_{ADC} = 400 kHz.



Crosstalk dependency towards channel switching frequency

5.1.2. Connecting to the object

The input port of the QMS10 module is described in the table, where **Xn** —non-inverting, and **Yn** — inverting inputs of the differential channel **n**; NC — the pin is reserved.

Pin num.	Description	Pin num.	Description
1	**+15 V** (analog supply) output	20	**SYN** – synchronization input[1]
2	**-15 V** (analog supply) output	21	**AGND32**–ground for single-ended mode
3	**AGND** – Analog ground [2]	22	X16 input
4	Y16 input	23	X15 input
5	Y15 input	24	X14 input
6	Y14 input	25	X13 input
7	Y13 input	26	X12 input
8	Y12 input	27	X11 input
9	Y11 input	28	X10 input
10	Y10 input	29	X9 input

[1] *Allowable potential on the SYN input is 0… 3,5 V relative to the ground (contacts 11, 28).*

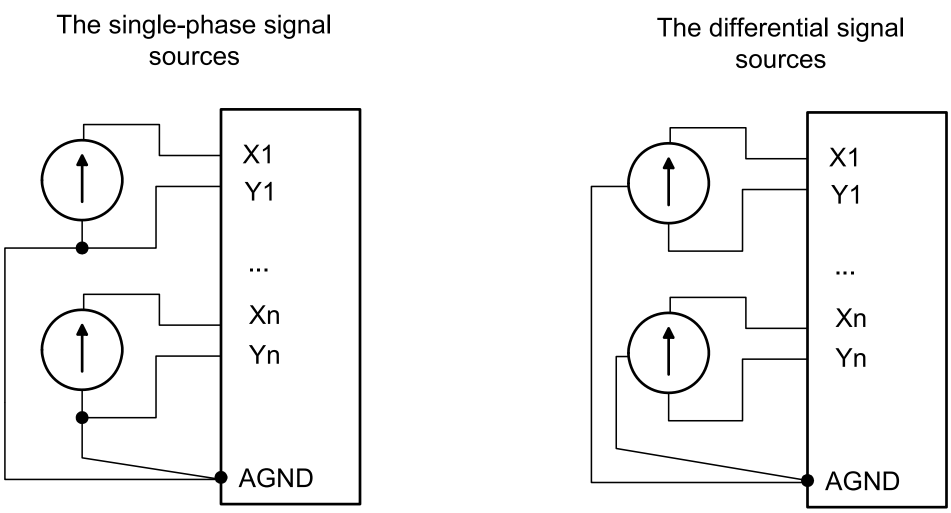
[2] *Analog ground is connected to USB ground inside the device.*

11	Y9 input	30	X8 input
12	Y8 input	31	X7 input
13	Y7 input	32	X6 input
14	Y6 input	33	X5 input
15	Y5 input	34	X4 input
16	Y4 input	35	X3 input
17	Y3 input	36	X2 input
18	Y2 input	37	X1 input
19	Y1 input		

The correct connection of the sources of analog signal is the most important condition of the correct operation of acquisition system which allows avoiding a lot of problems during the device operation. During the connection of the sources of analog signal to the device it is necessary to keep to the following recommendations:

1. Differential connection presupposes measuring voltage difference between the inverting and non-inverting inputs of the channel, i.e. differential voltage. However, it is necessary to remember that **the voltage in relation to the analogue ground of the device on both inputs (common-mode voltage) should not be higher than the acceptable input signal range**.
2. Correct connection of a signal to the differential input is always a **three-wire connection**. It is necessary to separate signal wires connected to a high-impedance input from the common ground wire. Thus, circuit of high current through signal wires, which reduces measurement accuracy, is eliminated.
3. When several signal sources are connected to the device, it is advisable that their common wires connect **at one point only**, on the **AGND** pin of the input port. This will eliminate formation of “ground loops” that are a source of extra noise.
4. The unused analogue inputs should be grounded — i.e. just to be connected with AGND pins of the input port. Unused digital inputs could be left disconnected.

On the scheme there are the examples of the correct connection of 1-phase and 2-phase (differential) signal sources to the device. Note that even single-phase signal sources should be connected to a differential input with three wires!

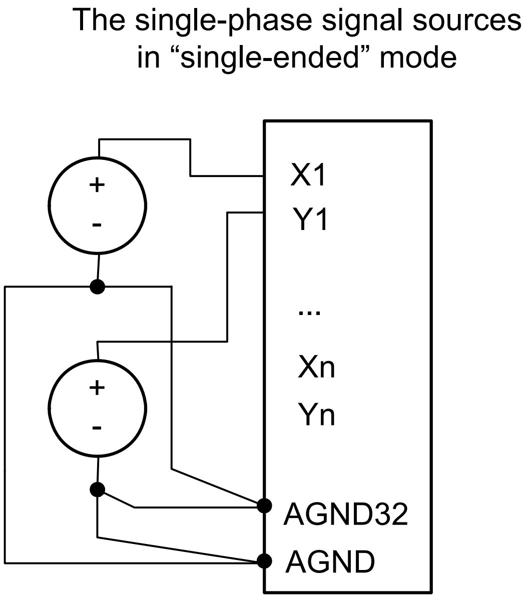


Single phase and differential connection

Differential connection of a signal source reduces the level of common-mode noise. Besides, differential inputs allow connecting signal sources so that currents of signal circuits do not flow through a single wire, which increases measurement accuracy.

Single-ended input mode permits doubling the number of channels when the use of differential inputs is not required.

On the scheme there is the example of the correct connection of 1-phase signal sources to the module in “single-ended” mode:



Common ground connection scheme

5.2. QMS15 ADC Module

QMS15 is a multichannel ADC module with 16 differential / 32 single-ended analog inputs.

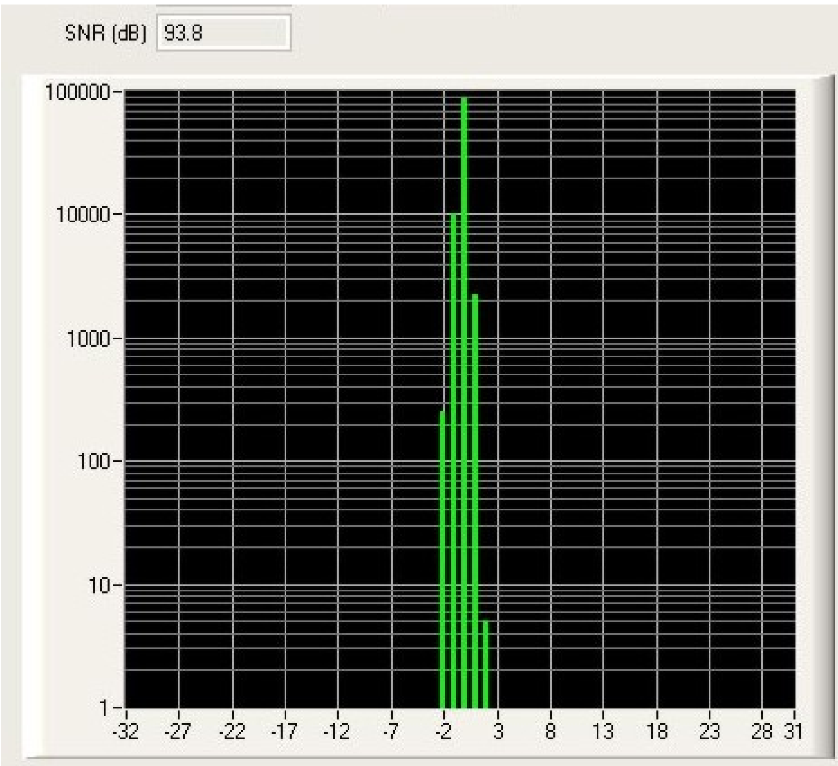
- ADC Resolution: 16 bits
- High sensitivity: 0.1 mV
- Signal-to-Noise ratio: 96.7 dB
- Max. aggregate throughput: 0.5 MS/s
- Low input current and capacity
- 3 programmable input ranges: ±1.5 V, ±4.5 V, ±10 V

5.2.1. Specifications

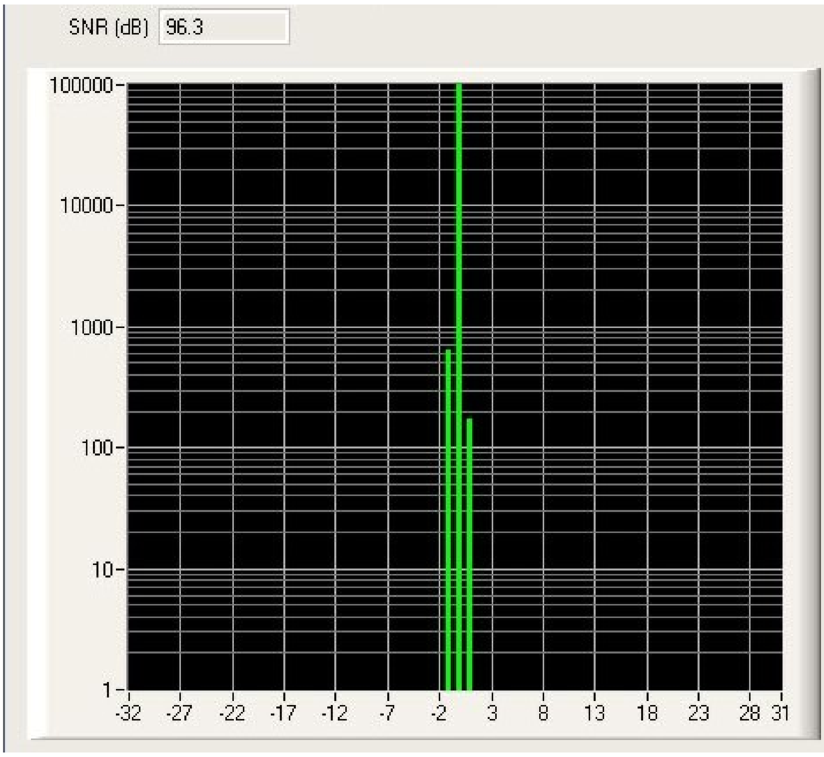
Number of input channels	16 differential / 32 single-ended
Input signal ranges (programmable per channel)	±10 V, ±4.5 V, ±1.5 V

Max. aggregate throughput (all channels)	0.5 MS/s
Max. sampling rate (one channel)	0.5 MS/s
ADC resolution	16 bits
Sensitivity - at input range ± 1.5 V - at input range ± 4.5 V - at input range ± 10 V	 0.1 mV 0.2 mV 0.6 mV
Noise voltage RMS - at input range ± 1.5 V - at input range ± 4.5 V - at input range ± 10 V	 0.035 mV (-93.8 dB) 0.08 mV (-96.3 dB) 0.15 mV (-96.7 dB)
Max. reduced to rage basic error - at input range ± 1.5 V - at input range ± 4.5 V - at input range ± 10 V	 0.01 % 0.01 % 0.02 %
Typical input current	0.1 nA
Typical input capacity	25 pF
Typical non-linearity of conversion	0.01 %
Typical common-mode rejection	-75 dB
Input overvoltage protection: - Permanent overvoltage (10 s) - Impulse (1 ms)	 ±25 V ±250 V

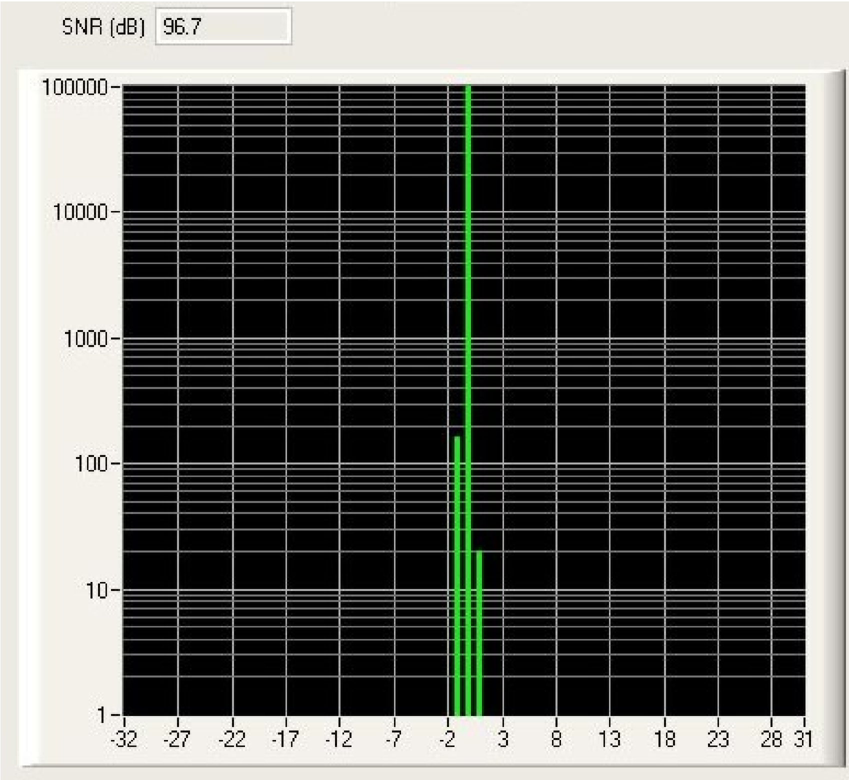
Typical QMS15 ADC characteristics are shown below.



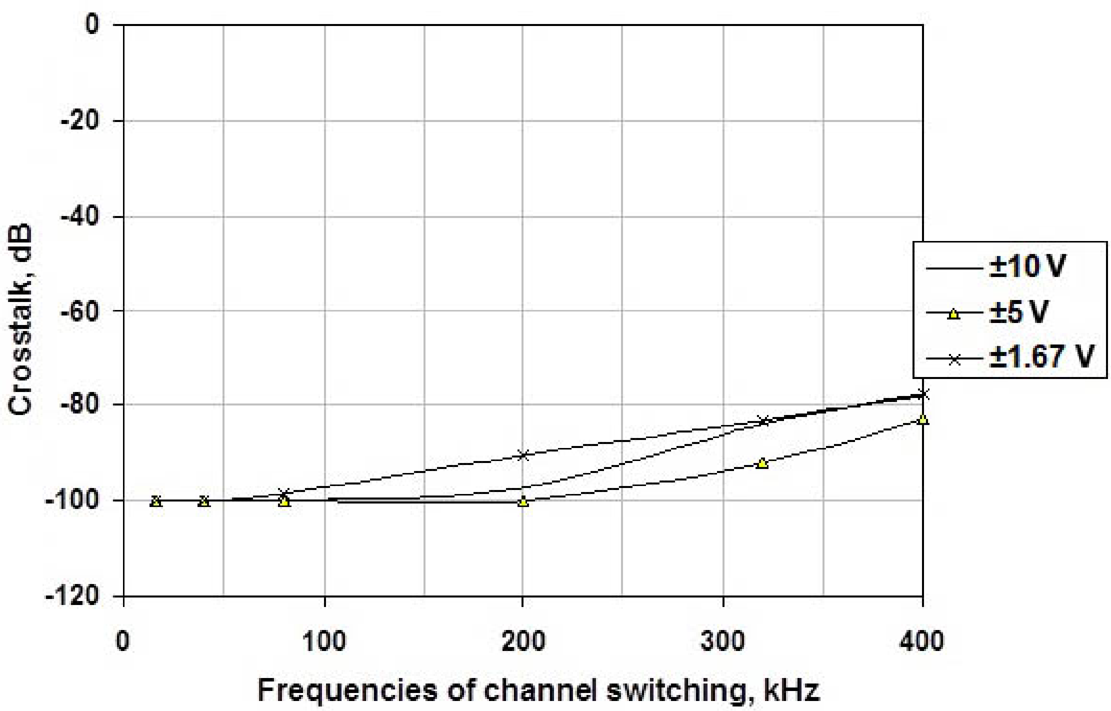
Distribution of the results from ADC at the range ± 1.5 V with input voltage 0 V.
X - ADC codes, Y - the number of results (in logarithmic scale).



Distribution of the results from ADC at the range ± 4.5 V with input voltage 0 V.
X - ADC codes, Y - the number of results (in logarithmic scale).



Distribution of the results from ADC at the range ± 10 V with input voltage 0 V.
X - ADC codes, Y - the number of results (in logarithmic scale).



Crosstalk function of channel switching frequency

5.2.2. Connecting to the object

The input port of the QMS15 module is described in the table below, where **Xn** —non-inverting, and **Yn** — inverting inputs of the differential channel **n**; NC — the pin is reserved.

Pin num.	Description	Pin num.	Description
1	**+12 V** (power supply) output	20	**SYN** – synchronization input[1]
2	**-12 V** (power supply) output	21	**AGND32**–ground for single-ended mode
3	**AGND** – Analog ground	22	X16 input
4	Y16 input	23	X15 input
5	Y15 input	24	X14 input
6	Y14 input	25	X13 input
7	Y13 input	26	X12 input
8	Y12 input	27	X11 input
9	Y11 input	28	X10 input
10	Y10 input	29	X9 input
11	Y9 input	30	X8 input
12	Y8 input	31	X7 input
13	Y7 input	32	X6 input
14	Y6 input	33	X5 input
15	Y5 input	34	X4 input
16	Y4 input	35	X3 input
17	Y3 input	36	X2 input
18	Y2 input	37	X1 input
19	Y1 input		

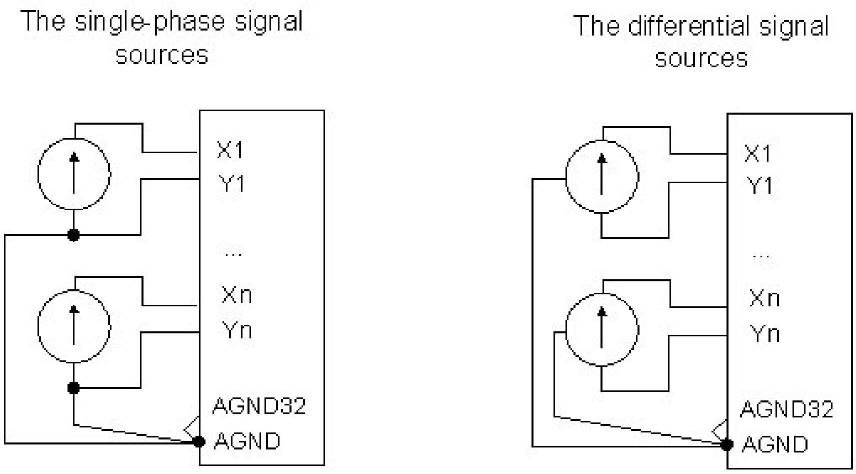
The correct connection of the sources of analog signal is the most important condition of the correct operation of acquisition system which allows avoiding a lot of problems during the device operation. During the connection of the sources of analog signal to the device it is necessary to keep to the following recommendations:

1. Differential connection presupposes measuring voltage difference between the inverting and non-inverting inputs of the channel, i.e. differential voltage. However, it is necessary to remember that **the voltage in relation to the analogue ground of the device on both inputs (common-mode voltage) should not be higher than the acceptable input signal range**.
2. Correct connection of a signal to the differential input is always a **three-wire connection**. It is necessary to separate signal wires connected to a high-impedance input from the common ground wire. Thus, circuit of high current through signal wires, which reduces measurement accuracy, is eliminated.

[1] *Allowable potential on the SYN input is 0… 5,5 V relative to the ground (contacts AGND).*

3. When several signal sources are connected to the device, it is advisable that their common wires connect **at one point only**, on the **AGND** pin of the input port. This will eliminate formation of “ground loops” that are a source of extra noise.
4. The unused analogue inputs should be grounded — i.e. just to be connected with AGND pins of the input port. Unused digital inputs could be left disconnected.

On the scheme below there are the examples of the correct connection of 1-phase and 2-phase (differential) signal sources to the device. Note that even single-phase signal sources should be connected to a differential input with three wires!

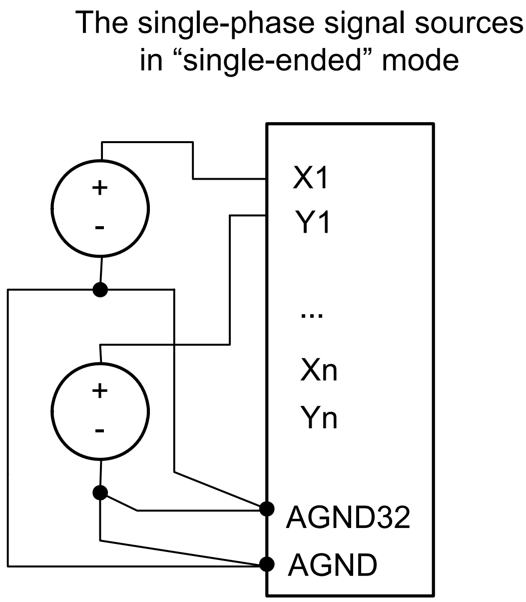


Single phase and differential connection

Differential connection of a signal source reduces the level of common-mode noise. Besides, differential inputs allow connecting signal sources so that currents of signal circuits do not flow through a single wire, which increases measurement accuracy.

Single-ended input mode permits doubling the number of channels when the use of differential inputs is not required.

On the scheme there is the example of the correct connection of 1-phase signal sources to the module in “single-ended” mode:



Common ground connection scheme

5.3. QMS20 ADC Module

QMS20 is a multichannel ADC module with 8 differential analog inputs.

- High max. sampling rate (one channel): 3 MS/s
- Low input current and input capacitance in any operation mode
- ADC resolution: 14 bits
- Two input signal ranges: ±5 V, ±0.99V (programmable per channel)

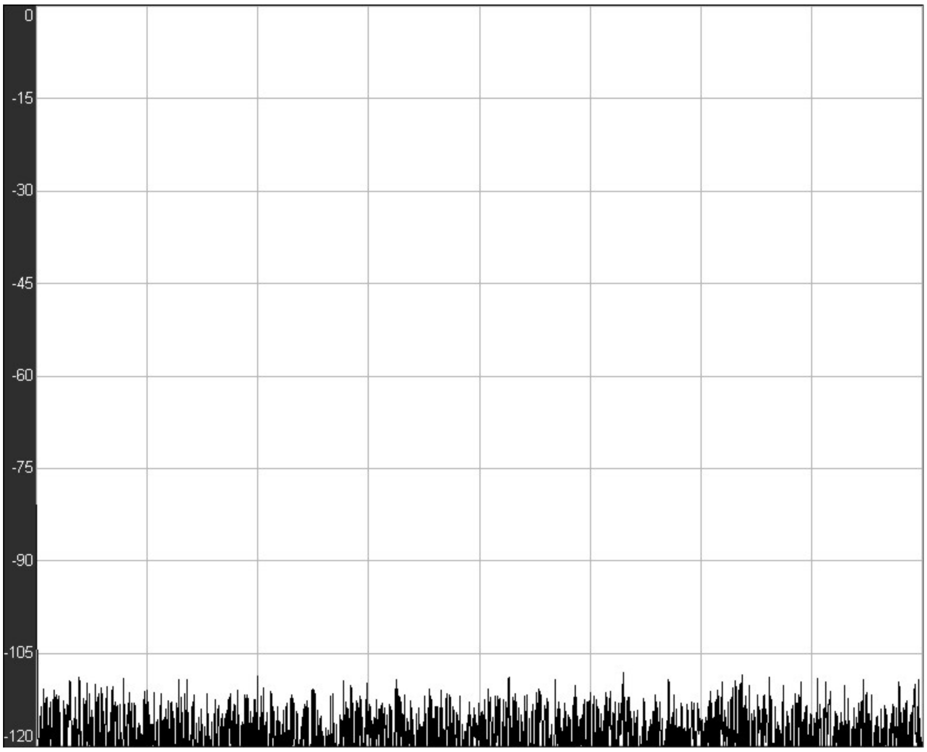
5.3.1. Specifications

Number of input channels	8 differential
Input signal range (programmable per channel)	± 5 V; ± 0.99 V
Max. aggregate throughput (all channels)	3 MS/s[1]
Max. sampling rate (one channel)	3 MS/s
ADC resolution	14 bits
Sensitivity - at input range ± 5 V - at input range ± 0.99 V	 1 mV 0.25 mV
Reference limiting error	0.05 %
Typical input current in any	0.1 nA

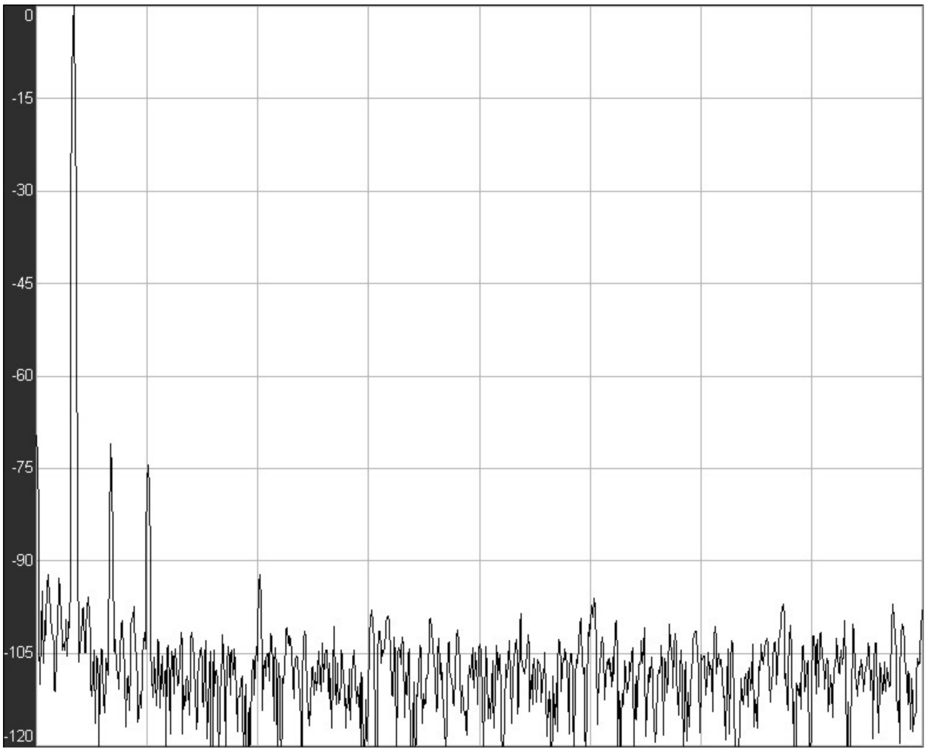
[1] *It should be taken into consideration that the overall rate of all the modules of QMBox device cannot be higher then 10 MS/s. For example, if QMBox device contains 4 (or more) QMS20 modules, only three of them can operate with maximum rate (3 Ms/s per module), and other modules of device must operate with rate not exceeding 10 – 3 * 3 = 1 MS/s.*

operation mode	
Typical input capacitance in any operation mode	25 pF
Typical common-mode rejection ratio (input signal 4 V, 10 kHz)	-75 dB
Typical crosstalk (for input signal 10 kHz with channel switching frequency 2 MHz)	-89 dB
Input overvoltage protection: - Permanent overvoltage (10 sec) - Impulse (1 ms)	±25 V ±250 V

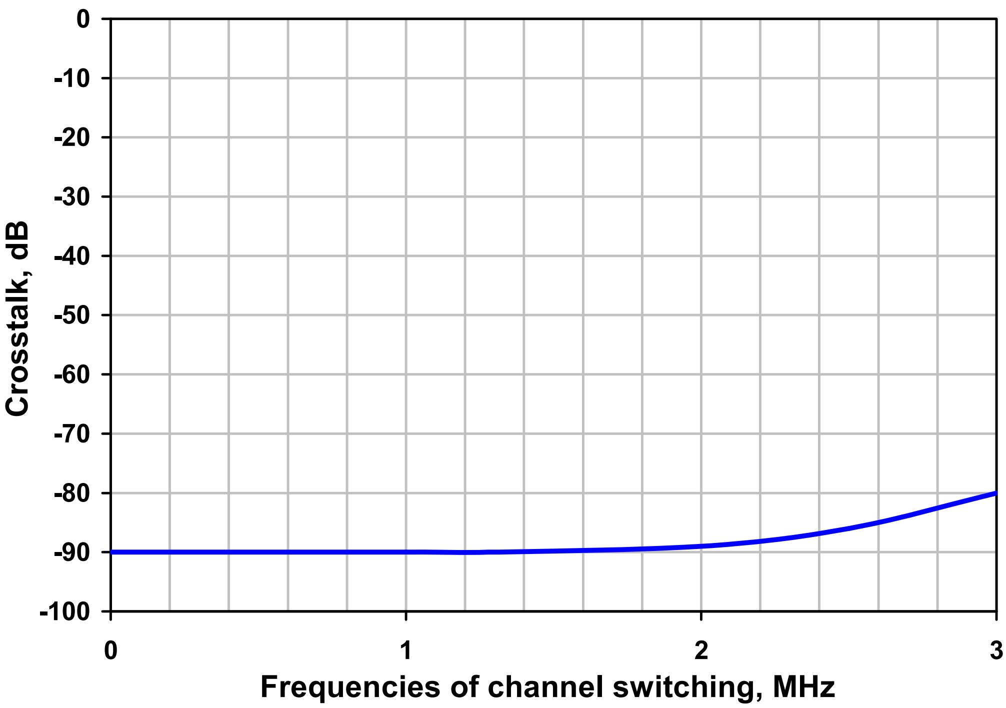
Figures below show typical characteristics of a QMS20 module: Harmonic distortion; noise in the ½ f_{ADC} band; the graph of Crosstalk dependency towards channel switching frequency.



Noise in the ½ f_{ADC} band (f_{ADC} = 3MHz)



Harmonic distortion. Input signal - sine-wave 10 kHz, 5V. f_{ADC} = 3MHz.



Crosstalk dependency towards channel switching frequency

5.3.2. Connecting to the object

The input port of the QMS20 module is described in the table, where **Xn** —non-inverting, and **Yn** — inverting inputs of the differential channel **n**; NC — the pin is reserved.

Pin num.	Description	Pin num.	Description
1	NC	20	NC
2	NC	21	NC
3	NC	22	NC
4	**+ 6 V** (analog supply) output	23	NC
5	**– 6 V** (analog supply) output	24	**SYN** – synchronization input[1]
6	NC	25	NC
7	NC	26	NC
8	NC	27	**+ 3.3 V** (digital supply) output
9	NC	28	NC
10	NC	29	**AGND** – Analog ground [2]
11	**AGND** – Analog ground	30	X8 input
12	Y8 input	31	X7 input
13	Y7 input	32	X6 input
14	Y6 input	33	X5 input
15	Y5 input	34	X4 input
16	Y4 input	35	X3 input
17	Y3 input	36	X2 input
18	Y2 input	37	X1 input
19	Y1 input		

The analogue inputs of the QMS20 module are differential. Differential connection of a signal source reduces the level of common-mode noise. Besides, differential inputs allow connecting signal sources so that currents of signal circuits do not flow through a single wire, which increases measurement accuracy.

The correct connection of the sources of analog signal is the most important condition of the correct operation of acquisition system which allows avoiding a lot of problems during the device operation. During the connection of the sources of analog signal to the module it is necessary to keep to the following recommendations:

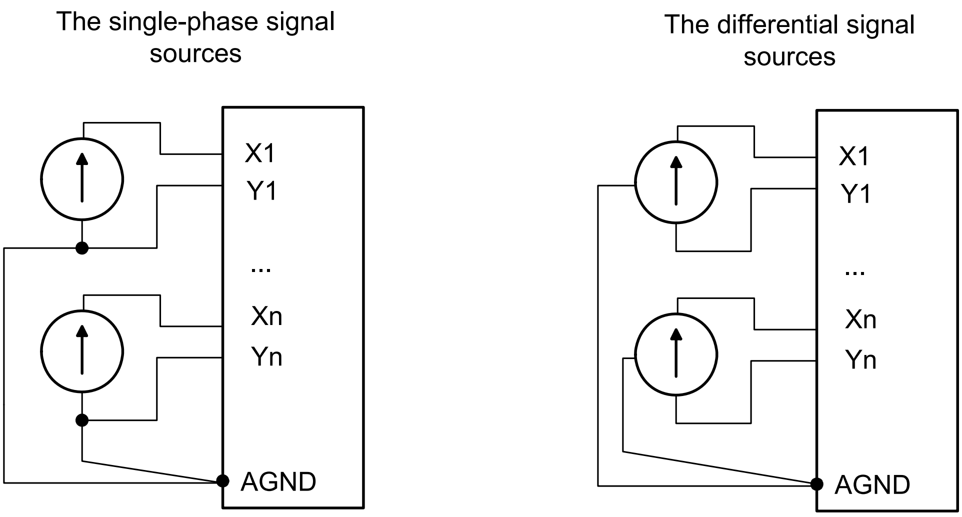
1. Differential connection presupposes measuring voltage difference between the inverting and non-inverting inputs of the channel, i.e. differential voltage. However, it is necessary to remember that **the voltage in relation to the analogue ground of the device on both inputs (common-mode voltage) should not be higher than the acceptable input signal range**.
2. Correct connection of a signal to the differential input is always a **three-wire connection**. It is necessary to separate signal wires connected to a high-impedance input from the common ground wire. Thus, circuit of high current through signal wires, which reduces measurement accuracy, is eliminated.

[1] *Allowable potential on the SYN input is 0… 3,5 V relative to the ground (contacts 11, 28).*

[2] *Analog ground is connected to USB ground inside the device.*

3. When several signal sources are connected to the device, it is advisable that their common wires connect **at one point only**, on the **AGND** pin of the input port. This will eliminate formation of "ground loops" that are a source of extra noise.

On the scheme there are the examples of the correct connection of 1-phase and 2-phase (differential) signal sources to the module. Note that even single-phase signal sources should be connected to a differential input with three wires!



Single phase and differential connection

5.4. QMS45 DAC Module

QMS45 is a multichannel DAC module with 8 independent optically isolated analog outputs.

- DAC resolution: 16 bits
- Output signal range: ±10 V
- Ultra-low glitch impulse
- Galvanic isolation of analog outputs from USB
- Stream output mode allows to generate non-periodic signals of arbitrary form and duration[1]

5.4.1. Specifications

Number of output channels	8
Output signal range	± 10 V

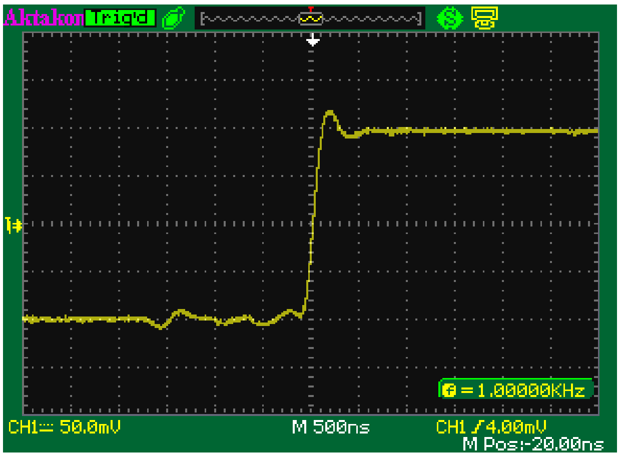
[1] *If QMBox device contains 2 (or more) QMS45 modules, only one of them can operate in stream output mode. Other DAC modules of the device can operate in oscillator mode only. In oscillator mode the module sends the contents of its internal buffer (the buffer size is 32 kS per channel) cyclically through the DAC without updating of the output data from PC. This mode is suitable for generating simple periodic signals and DC signals.*

DAC resolution	16 bits
Aggregate throughput (all channels)	1 MS/s
Conversion rate (one channel)	125 kS/s
Sensitivity	0.5 mV
Output voltage settling time (to ±0.0015% of full scale) - with ≤100 pF load - with ≤500 pF load	 ≤2 µs ≤4 µs
Typical THD + Noise (output current ≤100 mA)	90 dB
Reference limiting error	0.03 %
Max. output impedance	0.1 Ω
Max. load impedance	600 Ω
Switchable built-in filters	Butterworth 3rd rank low pass filter with 50 kHz cutoff frequency (at 3 dB)

5.4.2. Using the built-in filters

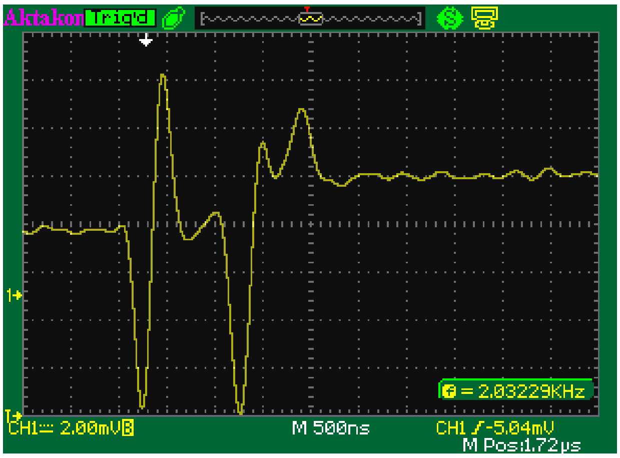
Each output channel module has two outputs - filtered (DAC signal passes through the built-in filter) and unfiltered (the same signal goes directly to the DAC).

Unfiltered output should be used when the terms of the task requires switching the signal levels in the shortest possible time. Module stabilizes desirable level in no more than 4 mks for the load with capacitance up to 500 pF, as it's shown in the figure below:



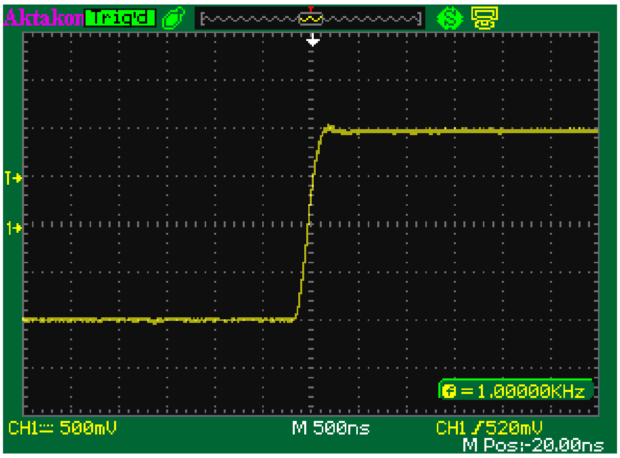
Non-filtered output with load with capacitance 470 pF

The use of unfiltered output may cause some problem when the smooth switching between output levels is required. Switching noise is clearly visible for small changes in the signal, as it's shown in the figure below:



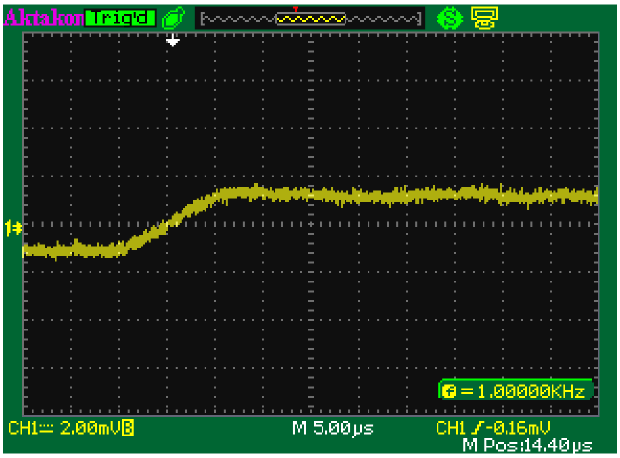
Changing the signal for 2 mV on non-filtered output

It should be noted, that the scope of switching noise doesn't depend on the strength of the measured signal. It means that in volts range this problem doesn't occurs, as it's shown on the figure below:



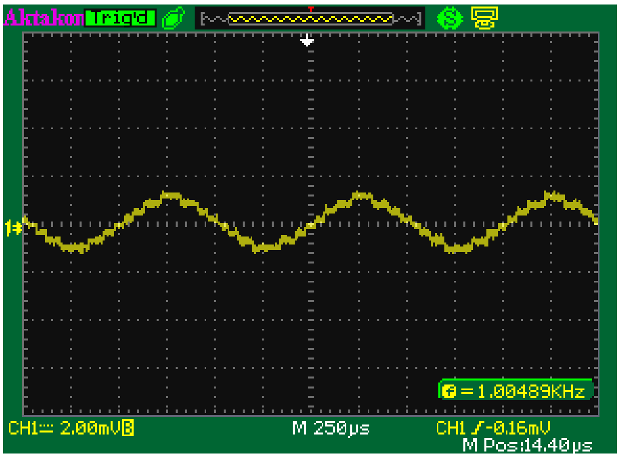
Changing the signal for 2 V on non-filtered output

Nevertheless, when smooth waves are generated, it's advisable to use filtered output. It will allow to eliminate switching noise and to reduce the impact of switching fronts on the shape of the signal.



Changing the signal for 2 V on filtered output

This method generates perfectly shaped signal with amplitudes from less than ±1 mV to ±10 V in the frequency range up to 50 kHz.



1 kHz ±1mV sine signal on filtered output

5.4.3. Connecting to the object

The input port of the QMS45 module is described in the table below

Pin num.	Description	Pin num.	Description
1	output **DAC1**	20	filtered output **FDAC1**
2	**COM1** – common 1	21	**ECOM1** – outer common **DAC1**
3	output **DAC2**	22	filtered output **FDAC2**
4	**COM2** – common 2	23	**ECOM2** – outer common **DAC2**
5	output **DAC3**	24	filtered output **FDAC3**
6	**COM3** – common 3	25	**ECOM 3** – outer common **DAC3**
7	output **DAC4**	26	filtered output **FDAC4**
8	**COM4** – common 4	27	**ECOM 4** – outer common **DAC4**
9	output **DAC5**	28	filtered output **FDAC5**
10	**COM5** – common 5	29	**ECOM 5** – outer common **DAC5**
11	output **DAC6**	30	filtered output **FDAC6**
12	**COM6** – common 6	31	**ECOM 6** – outer common **DAC6**
13	output **DAC7**	32	filtered output **FDAC7**
14	**COM7** – common 7	33	**ECOM 7** – outer common **DAC7**
15	output **DAC8**	34	filtered output **FDAC8**
16	**COM8** – common 8	35	**ECOM 8** – outer common **DAC8**
17	**AGND** – common[1]	36	output **- 12 V** (power output)
18	output **+ 12 V** (power output)	37	**AGND** – common
19	**SYN** – input for outer		

[1] *Analogue ground is connected to USB interface inside the device*

	synchronization[1]		

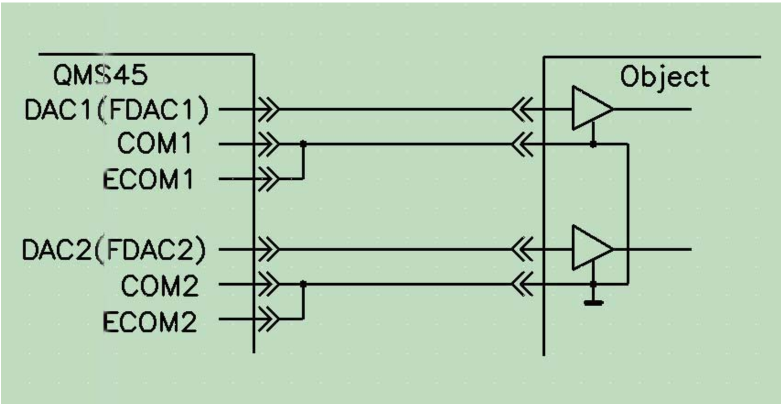
Each DAC channel takes 4 connectors:

DACx – non-filtered DAC output of channel **x**

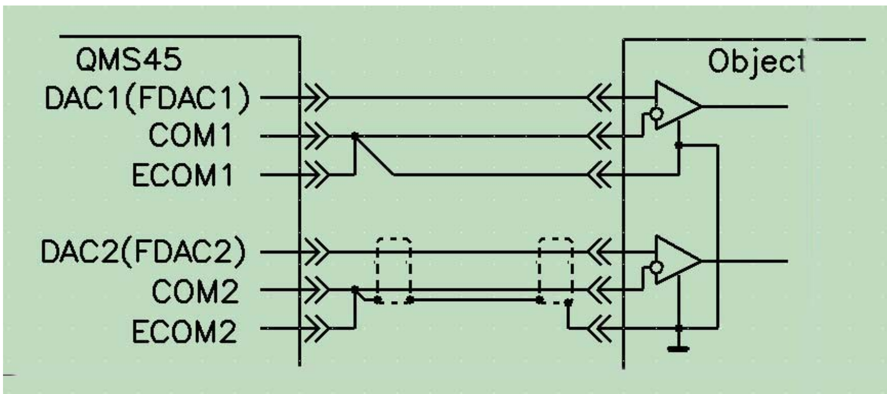
FDACx – filtered DAC output of channel **x**

COMx – contacts for connection of common (return) wire from DAC output channel x. All **COMx** contacts and **AGND** are connected inside the device, but to ensure minimum interference in a wide frequency range using **COMx** contacts with corresponding numbers are recommended.

ECOMx - inputs for common wire noise compensation. In the simplest scheme **ECOMx** inputs must be connected to the corresponding contacts **COMx** directly on the input port:



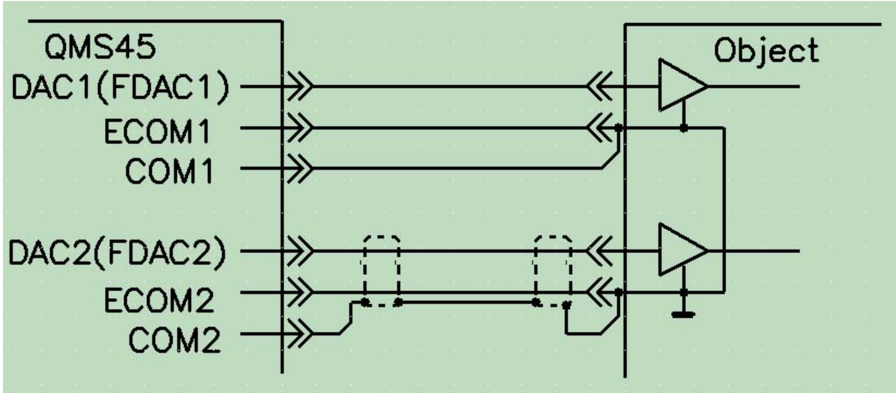
The connection of the devices without differential communication lines is exposed to stray currents induced by wires connected to a common circuit and poorly suppresses interference from the electromagnetic fields. Using such precise and broadband source as QMS45 suggests increased requirements to reduce noises in the circuit connected to the object. Therefore it's recommended to use differential inputs on the side of the object:



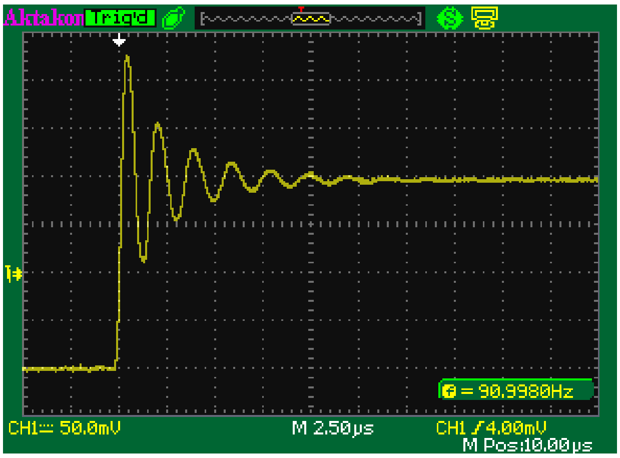
Especially high rate of noise reduction will be achieved with the use of shielded twisted pair, as shown for the channel number 2.

[1] *Max. allowed voltage on SYN – 0…5,5 V (to AGND)*

The application of such a scheme is possible only when the subject has the appropriate inputs (differential, high common mode rejection ratio in a wide range of frequencies). In most practical situations it is not. Therefore QMS45 has inputs noise compensation in return lines to ensure good signal-to-noise ratio. In this case the scheme for the majority of cases will be equivalent to the previous one:



When twisted pair, shielded or coaxial cables are used to connect the outputs of QMS45 to the inputs of remote objects, the load capacity should not exceed 500 to 1000 pF. Otherwise, as with any broadband source with low output impedance, the sustain problems can arise. This is especially significant for non-filtered outputs. Below is an example of the non-filtered output loaded with 4700 pF capacity behavior:



Non-filtered output loaded with 4700 pF capacity behavior

5.5. QMS70 discrete input module

QMS70 is a multichannel discrete input module with 16 independent, channel-to-channel isolated inputs.

- Several input ranges: from ± 5 V to ± 220 V
- Ability to interrogate the signals provided by both DC and AC voltage
- High-voltage galvanic isolation of inputs: 5 kV

5.5.1. Specifications

Number of inputs	16
Nominal value of input voltage (depending on the version)	± 5 V; ± 24 V, ± 220 V[1]
Input signals type	AC and DC
Minimum value of logical “1” input voltage (depending on the version)	± 4 V; ± 20 V, ± 150 V
Maximum value of logical “0” input voltage (depending on the version)	± 1 V; ± 5 V, ± 25 V
Aggregate throughput (all channels)	4 kS/s
Sampling rate	0.25 kS/s per channel
Galvanic isolation of input channels from USB	5 kV (3.75 kV RMS)
Channel-to-channel galvanic isolation	500 V
Input overvoltage protection, impulse 1 ms (depending on the version)	± 25 V; ± 110 V, ± 1000 V

5.5.2. Connecting to the object

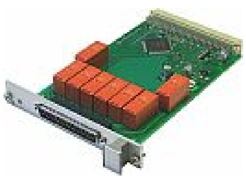
The input port of the QMS70 module is described in the table, where **Xn** and **Yn** — inputs of the discrete channel **n**; NC — the pin is reserved.

Pin num.	Description	Pin num.	Description
1	X16 input	20	Y16 input
2	X15 input	21	Y15 input
3	X14 input	22	Y14 input
4	X13 input	23	Y14 input
5	X12 input	24	Y12 input
6	X11 input	25	Y11 input
7	X10 input	26	Y10 input
8	X9 input	27	Y9 input
9	X8 input	28	Y8 input

[1] *Nominal value of input voltage is specified by the customer when ordering. Custom-made versions with other voltage values are available.*

10	X7 input	29	Y7 input
11	X6 input	30	Y6 input
12	X5 input	31	Y5 input
13	X4 input	32	Y4 input
14	X3 input	33	Y3 input
15	X2 input	34	Y2 input
16	X1 input	35	Y1 input
17	NC	36	NC
18	NC	37	NC
19	NC		

5.6. QMS75 relay switching module



QMS75 is a relay switching module. It has 8 independent, galvanically isolated relays.

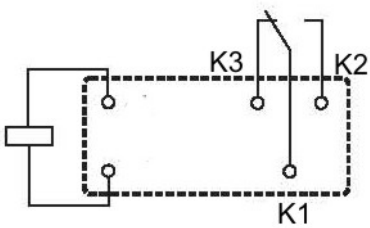
- High max. switching voltage/current: up to 400 V / 5 A (per channel)
- High-voltage galvanic isolation of relays: 3 kV
- Channel-to-channel galvanic isolation

5.6.1. Specifications

Number of relays	8
Relay type	Electromagnetic
Max. switching current	3 A (5 A for 1 sec)
Max. switching voltage	±250 V (allowable inductive load switching at overshoot of up to ±400 V)
Galvanic isolation of relay channels from USB	3 kV
Channel-to-channel galvanic isolation	750 V

5.6.2. Connecting to the object

Default contact configuration (after power on) of each relay:



The port of the QMS75 module is described in the table, where NC — the pin is reserved.

Pin num.	Description	Pin num.	Description
1	K1, Relay #7	20	K1, Relay #8
2	K2, Relay #7	21	K2, Relay #8
3	K3, Relay #7	22	K3, Relay #8
4	K1, Relay #6	23	NC
5	K2, Relay #6	24	NC
6	K3, Relay #6	25	NC
7	K1, Relay #5	26	NC
8	K2, Relay #5	27	NC
9	K3, Relay #5	28	NC
10	K1, Relay #4	29	NC
11	K2, Relay #4	30	NC
12	K3, Relay #4	31	NC
13	K1, Relay #3	32	NC
14	K2, Relay #3	33	NC
15	K3, Relay #3	34	NC
16	K1, Relay #2	35	K1, Relay #1
17	K2, Relay #2	36	K2, Relay #1
18	K3, Relay #2	37	K3, Relay #1
19	NC		

6. S series ADC submodules

'S' series submodules are single-channel AD Converters designed for measurements with channel-to-channel galvanic isolation, including those for interrogating of remote industrial sensors – thermocouples, thermistors, current loop sensors etc.

'S' series common specifications:

Sampling rate	0.25 kS/s per channel
ADC resolution	12 bits
Galvanic isolation of input channels from USB	1000 V
Channel-to-channel galvanic isolation	500 V

'S' series submodules are installed into slots on QMS301 – Carrier module. One QMS301 module may carry up to 16 'S' series ADC of various types and combined in different ways.

Carrier module QMS301 with four 'S' series submodules installed is shown below:

6.1. S20 – current measurement

S20 is a single-channel ‘S’ series ADC for current measurement.

Specifications:

Sensor connection	2-wire
ADC resolution	12 bits
Sampling rate	0.25 kS/s
Input signal range	0…20 mA. Custom-made versions with the ranges: 0 … 5 mA, ±5 mA, and ±20 mA are available
Reference limiting error	±0.075 %.

6.2. S30 – voltage measurement

S30 is a single-channel ‘S’ series ADC for voltage measurement.

Specifications:

Sensor connection	2-wire
ADC resolution	12 bits
Sampling rate	0.25 kS/s
Input signal range	±10 V. Custom-made versions with other ranges, including millivolt ones, are available.
Reference limiting error	±0.075 %.

6.3. S40 – thermocouples interrogation

S40 is a single-channel ‘S’ series ADC for thermocouples interrogation. All types of thermocouples are supported (according to IEC 60584-1).

Specifications:

Sensor connection	2-wire
Thermocouples type	According to IEC 60584-1, including E, J, K, R, S, T, B, N, L, M
ADC resolution	12 bits
Sampling rate	0.25 kS/s
Input signal range	-25 mV…+75 mV
Reference limiting error	±0.075 %.

6.4. S50 – resistance measurement

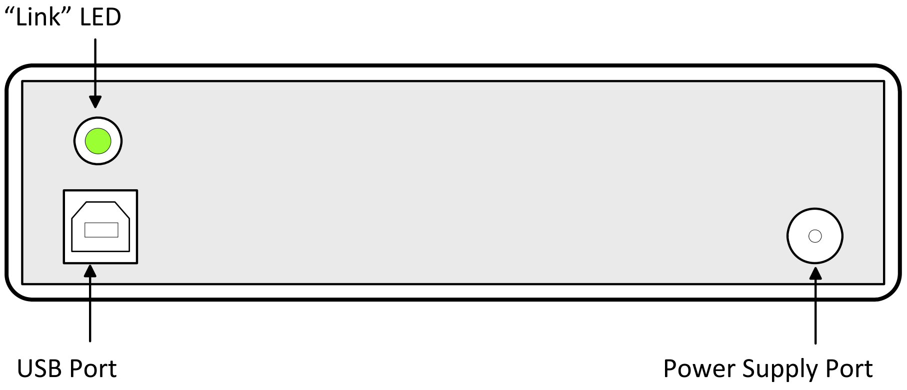
S50 is a single-channel 'S' series ADC for resistance measurement, including thermistors.

Specifications:

Sensor connection	2-wire, 3-wire, 4-wire
ADC resolution	12 bits
Sampling rate	0.25 kS/s
Input signal range	0…250 Ω. Custom-made versions with other ranges are available
Reference limiting error	±0.075 %

7. Connection of the device

The figure shows the rear panel of a QMBox device:



"Link" LED — turns on when the device is connected to USB and signals that the USB port of the computer has identified the device correctly.

USB port — type B. A standard connector for connecting the device to the PC via USB with an standard USB A-B cable.

Power Supply Port — it is used for supplying power from an external supply included in the delivery set.

The procedure of connecting the QMBox series devices is as follows:

1. Connect the power supply from the delivery set of the device to the Power Supply Port of the device.
2. Connect the power supply from the delivery set of the device to AC network.
3. Connect the device to the PC via a USB cable. At this the “Link” LED should turn on. When the device is connected for the first time, driver installation might be required. For further information see Connecting the device to the PC for the first time.
4. Connect the signal sources to the device — see Connecting to the object.

The procedure of disconnecting the QMBox series devices:

1. Disconnect the object (signal sources) from the device.
2. Disconnect the device from the PC.
3. Disconnect the power supply from the AC network.
4. Disconnect the power supply from the device.

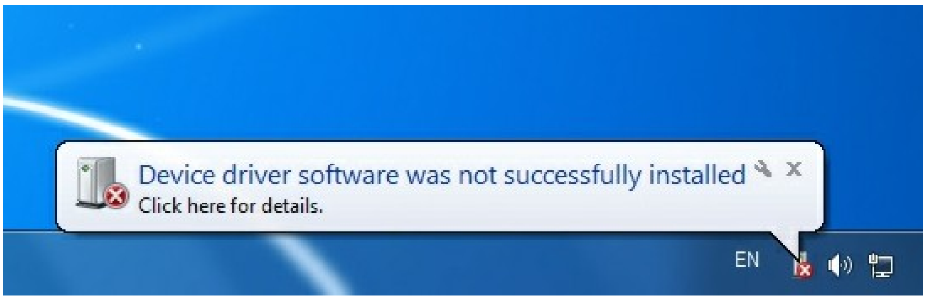
7.1. Connecting the device to the PC for the first time

When the QMBox series device is connected to a Windows PC for the first time, it is necessary to specify the location of the device driver.

Before connecting the device to the PC for the first time you should first insert the included CD into the CD-ROM drive of your PC and only then connect the device to the PC via a USB cable.

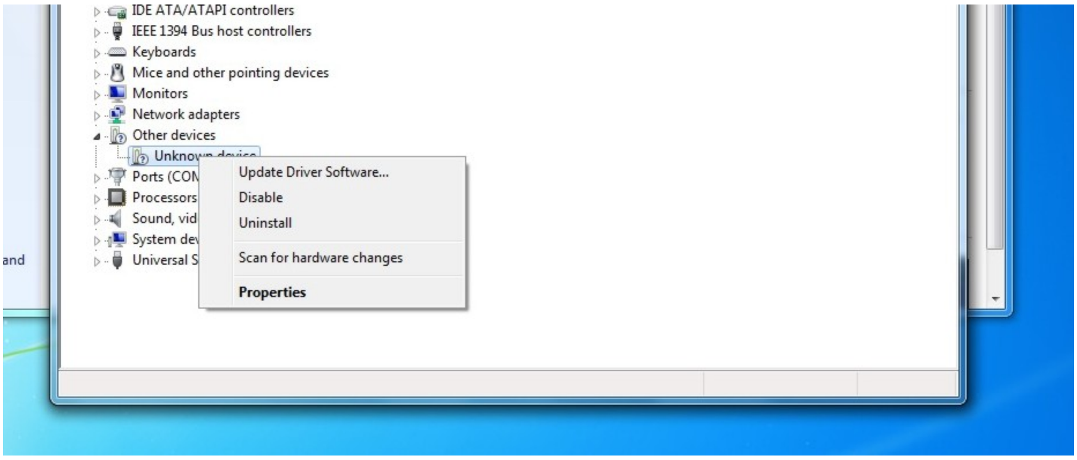
As a rule, having detected a new device, Windows starts the Found New Hardware Wizard. In this case you should follow its instructions, choosing not to go to the Windows Update site and specifying the “\DRV” folder on the included CD as the location of the driver.

Windows might not start the Found New Hardware Wizard automatically, returning a driver error message in the notification area (in the right bottom corner of the screen):

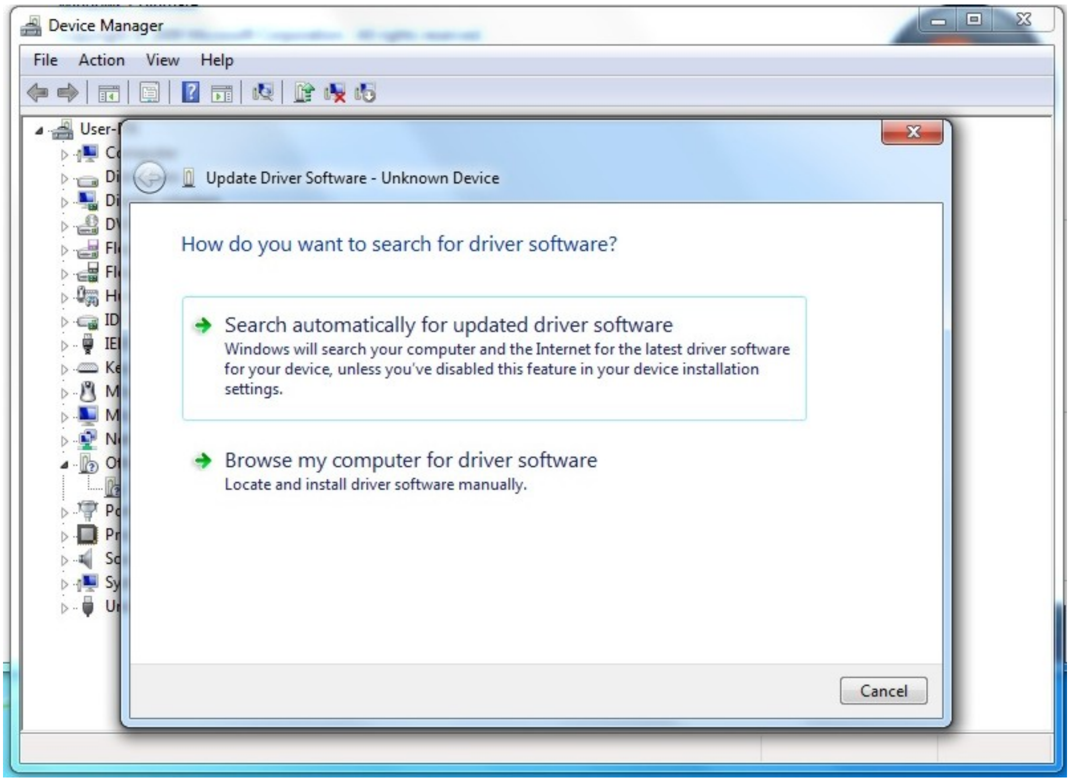


In this case you should start the Device Manager. In different Windows OS versions the Device Manager is started differently. For example, in Windows 7 it can be started by right-clicking the Computer icon, then – Properties, and then – Device Manager.

In the Device Manager QMBox device will appear as Unknown device. You should right-click on it and select “Update Driver Software”:

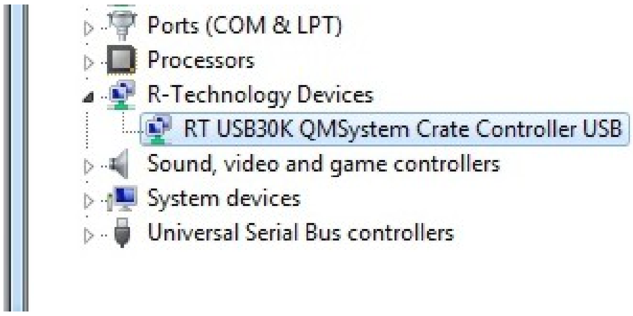


After this the Found New Hardware Wizard will start up:



You should select “Browse my computer for driver software” and specify the “\DRV” folder on the included CD as the location of the driver.

Then you should follow the instructions of the Wizard. Once the driver is successfully installed, the “RT USB30K QMSystem Crate Controller USB” device should appear in the Device Manager:

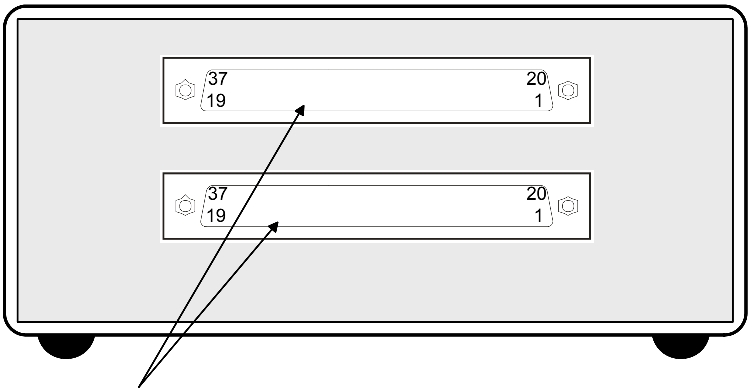


This means that the device's Interface board has been identified correctly by the PC, the driver is installed and the device is ready to work.

Afterwards, when the QMBox device is connected to another USB port of the PC, Windows might once again detect the QMBox device as "unknown device". In this case you will have to repeat the driver installation procedure as described above.

7.2. Connection to the object

The figure shows the front panel of a QMBox device (2-modules model modules):



Input Ports

Every functional module which is a part of the QMBox device has its own input port for the signals connection.

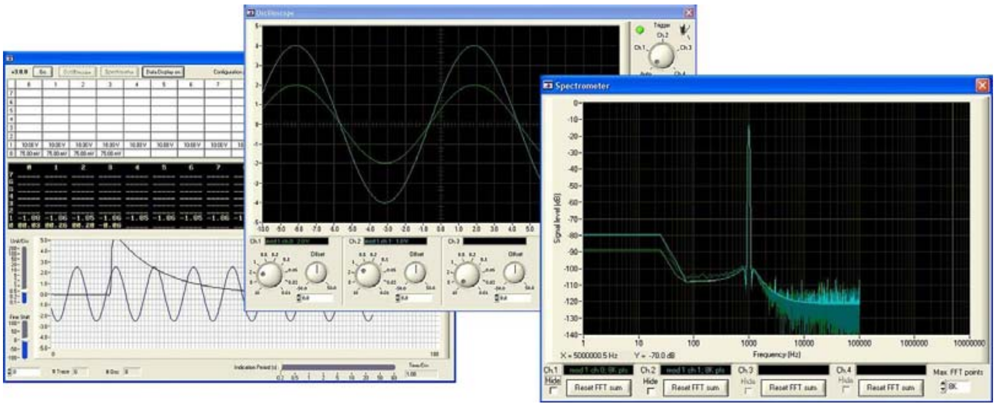
The input ports for each module type are described in chapter Functional modules used in the QMBox series devices

8. Software

QMBox software consists of following components:

- QMLab software suite
- Software development kit (SDK package)

8.1. QMLab software suite



The QMLab software suite is a universal software tool for working with QMBox devices. It allows performing most standard tasks within measurement automation.

The QMLab suite allows you to start work immediately after the device is connected: acquire, process, visualize and save the already calibrated data converted to the required measurement units without help of programmers or metrologists.

The QMLab suite includes:

- data recorder;
- oscilloscope;
- spectrum analyser;
- generator of analogue signals;
- primary data processing unit.

Primary data processing may include calibration, averaging, normalization in accordance with IEC for a specific type of sensor, as well as a more complex mathematical processing. For example, for thermocouples there is an automatic software compensation of cold junction and linearization of the transfer parameter.

Obtained data is saved in standard text and binary formats suitable for conventional and specialized data processing programs (Excel, MathLAB, Cool Edit pro, etc.). The generator of analogue signals, included in QMLab software suite, supports all QMBox series DAC devices. The program allows you to use the DAC as a multichannel generator of sinusoidal signals, DC signals, as well as signals of arbitrary waveforms (by "playing" through the DAC user's binary files of arbitrary length).

QMLab software suite is free of charge. A detailed description of the QMLab suite is given in the **"QMLab User Manual"** document that can be found on the site www.daq.lt and on the CD supplied with the device.

8.2. Software development kit

Apart from the complete QMLab software suite, the QMBox delivery set includes an SDK package, which is software and documentation designed for users who would like to create their own applications for working with the device. This software consists of function libraries (API) and examples of software development.

The user has a possibility to create full-blown applications using just a limited number of library functions. These library functions are written so that even an inexperienced programmer who is not well-versed in multithreaded and object-oriented programming can work with the device. A more detailed description of the software development kit is given in the **"QMBox Programming Guide"** document that can be found on the site www.daq.lt and on the CD supplied with the device.